



# INSTITUTE OF AERONAUTICAL ENGINEERING

Dundigal, Hyderabad - 500 043

## ELECTRONICS AND COMMUNICATION ENGINEERING

### QUESTION BANK

<b>Course Name</b>	:	<b>Electromagnetic Theory and Transmission Lines (EMTL)</b>
<b>Course Code</b>	:	A40411
<b>Class</b>	:	II - B. Tech
<b>Branch</b>	:	ECE
<b>Year</b>	:	2016 – 17
<b>Course Coordinator</b>	:	Ms. A. Usha Rani, Associate Professor.
<b>Course Faculty</b>	:	Ms. A. Usha Rani, Associate Professor. Mr.G.Nagendra Prasad, Associate Professor.

### OBJECTIVES

This course has the basics of electric and magnetic fields such as different charge densities, flux (electric and magnetic), scalar and vector potentials, emf, mmf, and capacitance induced and propagation of EM waves through

- To introduce the concept of co-ordinate systems and types to analyze the motion of object and their applications in free space to student.
- To impart the knowledge of electric and magnetic fields in real time applications.
- To introduce the fundamental theory of electromagnetic waves in transmission lines and their practical applications.
- To study the propagation characteristics of electromagnetic wave in bounded and unbounded media.
- To calculate various line parameters by conventional and graphical methods

S.No	QUESTION	Blooms taxonomy level	Course Outcome
<b>UNIT-I</b> <b>ELECTROSTATICS</b> <b>SHORT ANSWER QUESTIONS</b>			
1	State Coulomb's law?	Remembering	1
2	Write the expression for Coulombs law in vector form and explain the terms.	Remembering	1
3	Define unit vector?	Remembering	5
4	Specify the importance of divergence and stokes theorems?	Understanding	5
5	State Gauss's law?	Remembering	6
6	Give the expression for the potential difference of two concentric conducting sphere of radius a and b?	Understanding	6
7	List the applications of Gauss law?	Understanding	7
10	Define electric flux and give the relation between electric field intensity	Understanding	7

	and electric flux density?	ng	
11	Give the relation between electric flux and flux density?	Understandi ng	5
12	State the Divergence theorem and give the expression?	Understandi ng	5
13	State the stoke's theorem and give the expression?	Understandi ng	8
14	Define electric potential?	Understandi ng	3
15	What is the first Maxwell's equation?	Analysis	9
16	Define Electric Potential? Give the relation between V and E?	Understandi ng	10
17	Give the expression for the energy density for electrostatic fields?	Understandi ng	5
18	Give the expression for energy due to point Q in electric field?	Understandi ng	2
19	Define convention current density and conduction current density?	Understandi ng	1
20	Define polarization?	Understandi ng	5
21	Give the expression continuity equation?	Rememberin g	6
22	Give the expression for relaxation time?	Rememberin g	6
23	Define Poission and Laplace equations?	Rememberin g	5
24	Define capacitance between two parallel plates?	Analysis	5
25	Writ e boundary conditions for conducting media?	Analysis	7

### LONG ANSWER QUESTIONS

1	State Gauss's law. Using divergence theorem and Gauss's law, relate the displacement density D to the volume charge density $\rho_v$ .		
2	State and Prove Gauss's law. List the limitations of Gauss's law.		
3	Explain the following terms: i. Homogeneous and isotropic medium and ii. Line, surface and volume charge distributions.		
4	Derive the boundary conditions for the tangential and normal components of Electrostatic fields at the boundary between two perfect dielectrics..		
5	Using Gauss's law derive expressions for electric field intensity and electric flux density due to an infinite sheet of conductor of charge density $\rho_s$ C/cm		
6	State coulomb's law and write the equation for F that exist between two unlike charges?		
7	Derive the expression for potential difference between two points in an electric field.		
8	Explain and derive continuity equation?		
9	Explain convection current density and derive expression for it?		
10	State Gauss's law and obtain first Maxwell's equation for electrostatic fields?		
11	Obtain the expression for the capacitance of a coaxial capacitor?		
12	Derive poisons and Laplace's equations and mention their applications?		
13	Explain the terms conduction current, convection current and relaxation time.		
14	Define amperes circuit law and give the expression?		
15	List the applications of amperes circuit law?		

ANALYTICAL QUESTIONS			
1	Point charges Q1 and Q2 are respectively located at (4, 0, -3) and (2, 0, 1). If Q2 = 4 nC, find Q1 such that. i. The E at (5, 0, 6) has no Z-component. ii. The force on a test charge at (5, 0, 6) has no X-component.		
2	Derive the boundary conditions for the tangential and normal components of Electrostatic fields at the boundary between two perfect dielectrics.		
3	A parallel plate capacitance has 500mm side plates of square shape separated by 10mm distance. A sulphur slab of 6mm thickness with $\epsilon_r = 4$ is kept on the lower plate find the capacitance of the setup. If a voltage of 100 volts is applied across the capacitor, calculate the voltages at both the regions of the capacitor between the plates.		
4	If point charge $3 \mu\text{C}$ is located at the origin. Also there are two more charges $-4 \mu\text{C}$ and $5 \mu\text{C}$ are located at (2, -1, 3) and (0, 4, -2) respectively. Find potential at (-1, 5, 2) Assume zero potential at infinity.		
5	A point charge of 5 nC is located at the origin. If $V = 2\text{v}$ at (0, 6, -8), find i. The potential at A (-3, 2, 6) ii. The potential at B (1, 5, 7) iii. The potential difference $V_{AB}$		
6	Three point charges $2\mu\text{C}$ , $4 \mu\text{C}$ , $8 \mu\text{C}$ are located at (0,0,0), (0,0,1) and (1,0,0) respectively. Find energy in the system.		
7	A parallel-plate capacitor has plates located at $z = 0$ and $z = d$ . The region between plates is filled with a material containing volume charge of uniform density $\rho_0 \text{ C/m}^3$ , and which has permittivity. Both plates are held at ground potential. a) Determine the potential field between plates b) Determine the electric field intensity, E between plates.		
8	Concentric conducting spheres are located at $r = 5 \text{ mm}$ and $r = 20 \text{ mm}$ . The region between the spheres is filled with a perfect dielectric. If the inner sphere is at 100 V and the outer sphere at 0 V: a) Find the location of the 20 V equipotential surface, b) Find $E_{r,\text{max}}$ c) Find $\epsilon_r$ if the surface charge density on the inner sphere is $1.0 \mu\text{C/m}^2$		
UNIT -2 MAGNETOSTATICS SHORT ANSWER QUESTIONS			
1			
2	State Biot- Savart's law?		
3	State Ampere's force law?		
4	State Ampere's circuital law?		
5	Is magneto static field is conservative? Explain.		
6	Write the Maxwell equation for magneto static fields?		
7	Define magnetic vector potential and magnetic scalar potential?		
8	Write the expression for Lorentz force equation.		
9	Define inductance? What's the energy stored in an inductor?		
10	What is point form of ohms law?		
11	A filament is formed into a circle of radius a, centered at the origin in the plane $z = 0$ . It carries a current I in the $\mathbf{a}_\phi$ direction. Find $\mathbf{H}$ at the origin		
12	Write Maxwell's equation for static electric field and steady magnetic field, both in point and integral form.		

13	Determine the total energy stored in a spherical region 1cm in radius, centered at the origin in free space, in the uniform field of $H = -600\mathbf{a}_y$ A/m.		
14	State Gauss law for magnetic fields?		
15	Define displacement current density.		
16	Define magnetic flux density along with equation?		
17	Write the final equations of boundary conditions between conductor and free space?		
18	Write the final equations of boundary conditions between two dielectrics?		
19	Write the final equations of boundary conditions between conductor and dielectric?		
<b>LONG ANSWER QUESTIONS</b>			
1	Derive Ampere's circuital law in differential form?		
2	State and explain Biot- Savart's law?		
3	Derive the boundary conditions between conductor and free space?		
4	Derive the boundary conditions between two dielectrics?		
5	Derive the boundary conditions between conductor and dielectric?		
6	What is the inconsistency in Ampere's Law? How it is rectified by Maxwell?		
7	Describe in detail the Faraday's law of induction. Write down the mathematical statement of this law?		
8	Derive Maxwell's equations in integral form and differential form for time varying fields.		
9	Define and explain the terms scalar and vector magnetic potential? How to determine these quantities for a magnetic field?		
10	Prove the Maxwell's equation $\nabla \cdot \mathbf{B} = 0$ .		
11	Derive Lorentz force equation?		
12	Derive the equation of force on a differential current element?		
13	Write short notes on energy stored in a magnetic field?		
14	Derive the inductance of Solenoid?		
15	Obtain Maxwell's equations in phasor form?		
<b>ANALYTICAL QUESTIONS</b>			
1	A steady current element $10^{-3} \mathbf{a}_z$ Am is located at the origin in free space. What is the magnetic field $\mathbf{B}$ due to this element at the point $(1,0,0)\text{m}$ ?		
2	A $\mathbf{H}$ due to a current source is given by $\mathbf{H} = [\mathbf{y}\cos(\alpha x)] \mathbf{a}_x + (\mathbf{y} + e^x)\mathbf{a}_z$ . Describe the current density over the $yz$ plane?		
3	A radial field $\mathbf{H} = \frac{2.39 \times 10^6}{r} \cos\phi \mathbf{a}_r$ A/m exists in free space. Find the magnetic flux crossing the surface defined by $0 \leq \phi \leq \frac{\pi}{4}$ and $0 \leq z \leq 1 \text{ m}$ .		
4	If the vector magnetic potential within a cylindrical conductor of radius 'a' is $\mathbf{A} = \frac{\mu_0 I r^2}{4\pi a^2} \mathbf{a}_z$ , find $\mathbf{H}$ .		
5	Calculate the force on a straight conductor of length 30cm carrying a current of 5 A in $\mathbf{a}_z$ direction and the magnetic field $\mathbf{B} = 3.5 \times 10^{-3}(\mathbf{a}_x - \mathbf{a}_y)$ Tesla where $\mathbf{a}_x$ and $\mathbf{a}_y$ are unit vectors.		
<b>UNIT-3</b>			
<b>EM WAVE CHARACTERISTICS</b>			

### SHORT ANSWER QUESTIONS

1	What is uniform plane wave?		
2	What is meant by transverse electromagnetic wave?		
3	Define Skin depth?		
4	Write the expression for depth of penetration of a good conductor?		
5	What is meant by polarization of wave?		
6	Mention different types of polarization of a uniform plane wave?		
7	Recall the values of conductivity ( $\sigma$ ), permittivity ( $\epsilon$ ) and permeability ( $\mu$ ) for free space and lossless dielectric?		
8	Recall the values of conductivity ( $\sigma$ ), permittivity ( $\epsilon$ ) and permeability ( $\mu$ ) for perfect conductor and lossy dielectric?		
9	Define phase velocity and also write its expression?		
10	Write the equation of intrinsic impedance in both free space and in any medium?		
11	Write the equation of attenuation constant in both free space and in any medium?		
12	Write the equation of phase constant impedance in both free space and in any medium?		
13	Recall the equations of $\beta$ , $\lambda$ and ' $v$ ' for the wave propagating through perfect dielectric?		
14	Determine the depth of penetration for copper at 1MHz.		
15	What is loss tangent?		
16	Write the wave equation for <b>D</b> and <b>B</b> in the uniform medium?		
17	Write the wave equation for <b>E</b> and <b>H</b> in the uniform medium?		
18	Recall the equations of $\gamma$ , $\alpha$ , and ' $v$ ' for the wave propagating through perfect dielectric?		
19	Write briefly about lossy dielectric?		
20	Show the effect of attenuation constant $\alpha$ , on amplitude of a wave propagation in good conductor pictorially?		

### MID-II

1	Define plane of incidence?		
2	What is the difference between normal incidence and oblique incidence?		
3	What is Brewster angle?		
4	Define Surface impedance?		
5	Write snells law of reflection and refraction?		
6	What is total internal reflection?		
7	What is Critical angle?		
8	Write the expression for Brewster angle when a wave is parallelly polarized?		
9	What is transmission coefficient?		
10	Distinguish between terms perpendicular polarization and parallel polarization for the case of reflection by a perfect conductor under oblique impedance?		
11	Determine the critical angle for the electromagnetic wave passing through glass to air if $\epsilon_r$ for glass is 9.		
12	Write the expression transmission coefficient of an EM wave when it is incident normally on a dielectric?		
13	Write the expression reflection coefficient of an EM wave when it is incident normally on a dielectric?		
14	What is the difference between instantaneous poynting vector and complex poynting vector?		
15	Write point form of Poynting theorem?		
16	What is poynting vector?		
17	State Poynting theorem?		
18	Define complex Poynting vector?		

19	Define power loss in a plane conductor?		
20	What is skin depth?		
<b>LONG ANSWER QUESTIONS</b>			
1	Obtain wave equations for good conductors?		
2	Explain the characteristics of wave in perfect dielectric?		
3	What is the meant by polarization of wave? When the wave is linearly polarized and circularly polarized?		
4	Derive expression for intrinsic impedance in a uniform plane wave in a lossy dielectric?		
5	Explain skin depth and derive expression for depth of penetration for good conductor?		
6	Derive the expression for reflection of a wave when incident on dielectric with oblique incidence with perpendicular polarization?		
7	Define Brewster angle and derive an expression for Brewster angle when a wave is parallely polarized?		
8	State and Prove Poynting theorem?		
9	Explain the power loss in a plane conductor?		
10	Derive the expression for power flow in a concentric cable?		
<b>ANALYTICAL QUESTIONS</b>			
1	Find the skin depth and surface resistance of an aluminium at 100MHz having conductivity $\sigma = 5.8 \times 10^7$ mho/m, $\mu_r = 100$ .		
2	The electric field in the free space is given by, $E = 50 \cos(10^8 t + \beta x) \mathbf{a}_y$ V/m. i. Find the direction of propagation ii. Calculate $\beta$ and time it takes to travel a distance of $\lambda/2$ .		
3	A 10 GHz plane wave travelling in a free space has an amplitude of $E$ as $E_x = 10$ V/m. Find $\beta$ , $\eta$ , $v$ , $\lambda$ ?		
4	A plane wave travelling in free space has an average Poynting vector of 5 watts/m <sup>2</sup> . Find magnitude of electric field intensity?		
5	A uniform plane wave of 200 MHz travelling in a free space impinges normally on a large block of material having $\epsilon_r = 4$ , $\mu_r = 9$ , $\sigma = 0$ . Calculate transmission and reflection coefficients at the interface.		
<b>UNIT-IV</b>			
<b>TRANSMISSION LINES - I</b>			
<b>SHORT ANSWER QUESTIONS</b>			
1	Define transmission line? What are the different types of transmission lines?		
2	Draw the equivalent circuit of the transmission line?		
3	Write the differential form of transmission line equations?		
4	What are the different types of distortions in a transmission line and What's the condition for distortion less transmission?		
5	What is a distortion less transmission line? Is every loss less line is a distortion less line? Justify.		
6	Define intrinsic impedance or characteristic impedance of free space.		
7	Define wave length and phase velocity		
8	Define group velocity		
9	What is the condition of loading in transmission lines?		
10	What is the value of characteristic impedance of free space?		
11	Write secondary constants in terms of primary constants?		
12	Calculate the characteristic impedance of a quarter wave transformer if a 120 ohm load is to be matched to a 75ohm line.		
13	Write solution for V and I in exponential form?		
14	Write solution for V and I in the form of hyperbolic functions?		
15	Write the advantages and applications of		

16	Name and define the primary constants of transmission line?		
<b>LONG ANSWER QUESTIONS</b>			
1	Starting from the equivalent circuit, derive the transmission line equations for V and I, in terms of the source parameters.		
2	From the fundamental voltage & current equations of transmission line, derive Expression for input impedance $Z_{in}$ of the line. Modify the expression for lossy & lossless cases.		
3	What are the different distortions on a line and derive the conditions for distortion less transmission.		
4	What is loading? Explain the different types of loading in transmission lines?		
5	What are the different distortions on a line and derive the conditions for minimum attenuation?		
6	Derive the characteristic impedance $Z_0$ from the initial equation of transmission line?		
7	Derive the Propagation constant $\gamma$ from the general equations of Voltage and current?		
8	Derive the expressions for $\alpha$ and $\beta$ in terms of primary constants?		
9	Define wave length, velocity of propagation and group velocity and write the respective equations?		
10	Derive the expression for loss less transmission line?		
11	Draw the equivalent circuit of infinite line and show that its input impedance is equal to the characteristic impedance?		
12	Express constants A and B in terms of voltage and current from the general line equations?		
<b>ANALYTICAL QUESTIONS</b>			
1	At 8 MHz the characteristic impedance of transmission line is $(40 - j2) \Omega$ and the propagation constant is $(0.01 + j0.18)$ per meter. Find the primary constants.		
2	A loss less transmission line has $75 \Omega$ characteristic impedance. The line is terminated in a load impedance of $50 - j100 \Omega$ . The maximum voltage measured on the line is 100V. Find the maximum current and minimum voltage on the line.		
3	A transmission line in which no distortion present has the following parameters. $Z_0 = 50 \text{ ohm}$ , $\alpha = 20 \text{ mN/m}$ , $V = 0.7V_0$ . Determine primary constants and wave length at 0.1 GHz.		
4	Calculate the characteristic impedance, the attenuation constant and phase constant of a transmission line if the following measurements have been made on the line $Z_{OC} = 550 \Omega$ and $Z_{SC} = 500 \Omega$ .		
5	A generator of 1V, 1 KHz supplies power to a 100 km long line terminated in $Z_0$ and having the following constants, $R = 10.4 \Omega/\text{km}$ , $L = 0.00367 \text{ H/km}$ , $G = 0.8 \times 10^{-6} \text{ mho/km}$ and $C = 0.00835 \times 10^{-6} \text{ F/km}$ . Calculate $Z_0$ , attenuation constant $\alpha$ , phase constant $\beta$ , wavelength $\lambda$ and velocity V.		
<b>UNIT-V</b> <b>TRANSMISSION LINES - II</b> <b>SHORT ANSWER QUESTIONS</b>			
1	Define VSWR. What is its significance?		
2	What's the relationship between the short circuited impedance, open circuited impedance and characteristic impedance?		
3	Define reflection coefficient and VSWR, what is the relationship between them		
4	What is matched transmission line. Why is matching of load impedance is needed.		



5	List the properties of smith chart?		
6	What is meant by stub matching?		
7	What are short circuited and open circuited lines?		
8	Differentiate between matched and unmatched transmission line		
9	Differentiate between single stub and double stub matching.		
10	Why it is desirable to achieve an impedance match in a transmission line?		
11	Write applications of quarter wave line?		
12	What is the significance of circle diagram?		
13	A loss less line of $300\Omega$ characteristic impedance is terminated in a pure resistance of $200\Omega$ . Find the value of standing wave ratio.		
14	What is a standing wave and how it is produced?		
15	List the applications of smith chart?		
<b>LONG ANSWER QUESTIONS</b>			
1	Explain the principle of impedance matching with quarter wave transformer?		
2	Explain the significance and utility of $\lambda/8, \lambda/4$ and $\lambda/2$ line?		
3	Explain the significance and design of single stub impedance matching. Discuss the factors on which length depends?		
4	Describe the construction of smith chart and give its applications?		
5	Explain with neat sketches how the input impedance of a lossless line varies with frequency?		
6	Derive the relation between reflection coefficient and standing wave ratio?		
7	Derive the expression for the input impedance of an uniform transmission line terminated with load $Z_L$ . Hence discuss the properties of a quarter wave length and half wave length lines assuming the line to be loss less?		
8	Explain the significance of $V_{\max}$ and $V_{\min}$ positions along the transmission line, for a complex load $Z_R$ . Hence obtain expression for impedances at these positions?		
9	Explain the method of determining the input impedance of line using smith chart for a lossless of length $L$ at any frequency $f$ for a complex load of $Z_R$ .		
10	Derive expression for the input impedance of a lossless line. Hence evaluate $Z_{OC}$ and $Z_{SC}$ , also sketch their variation with line length?		
<b>ANALYTICAL QUESTIONS</b>			
1	Find the characteristic impedance of a line at 1600Hz if the following measurements have made on the line at 1600 Hz, $Z_{oc} = 750\Omega$ and $Z_{sc} = 500\Omega$ .		
2	A transmission line of length $0.4\lambda$ has a characteristic impedance of 100 and is terminated by a load impedance of $200 + j180 \text{ ohm}$ , by using smith chart find i. voltage reflection coefficient ii. VSWR iii. Input impedance of the line		
3	Calculate the characteristic impedance of a quarter wave transformer if a 120 ohm load is to be matched to a 75ohm line?		
4	A transmission line having 50 ohm impedance is terminated in a load of $(40 + j30) \text{ ohm}$ . What is the voltage standing wave ratio?		
5	A lossless line having an air dielectric has a characteristic impedance of 400 $\Omega$ . The line is operating at 200 MHz and $Z_{in} = 200 - j200 \Omega$ . Use the Smith chart, find: (a) S; (b) $Z_L$ if the line is 1 m long; (c) the distance from the load to the nearest voltage maximum		



**Date:** 30<sup>th</sup> November, 2016

**HOD, ECE**